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Collaboration and Coalition Architectures

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TC3 Workshop:

Cognitive Elements of Effective Collaboration

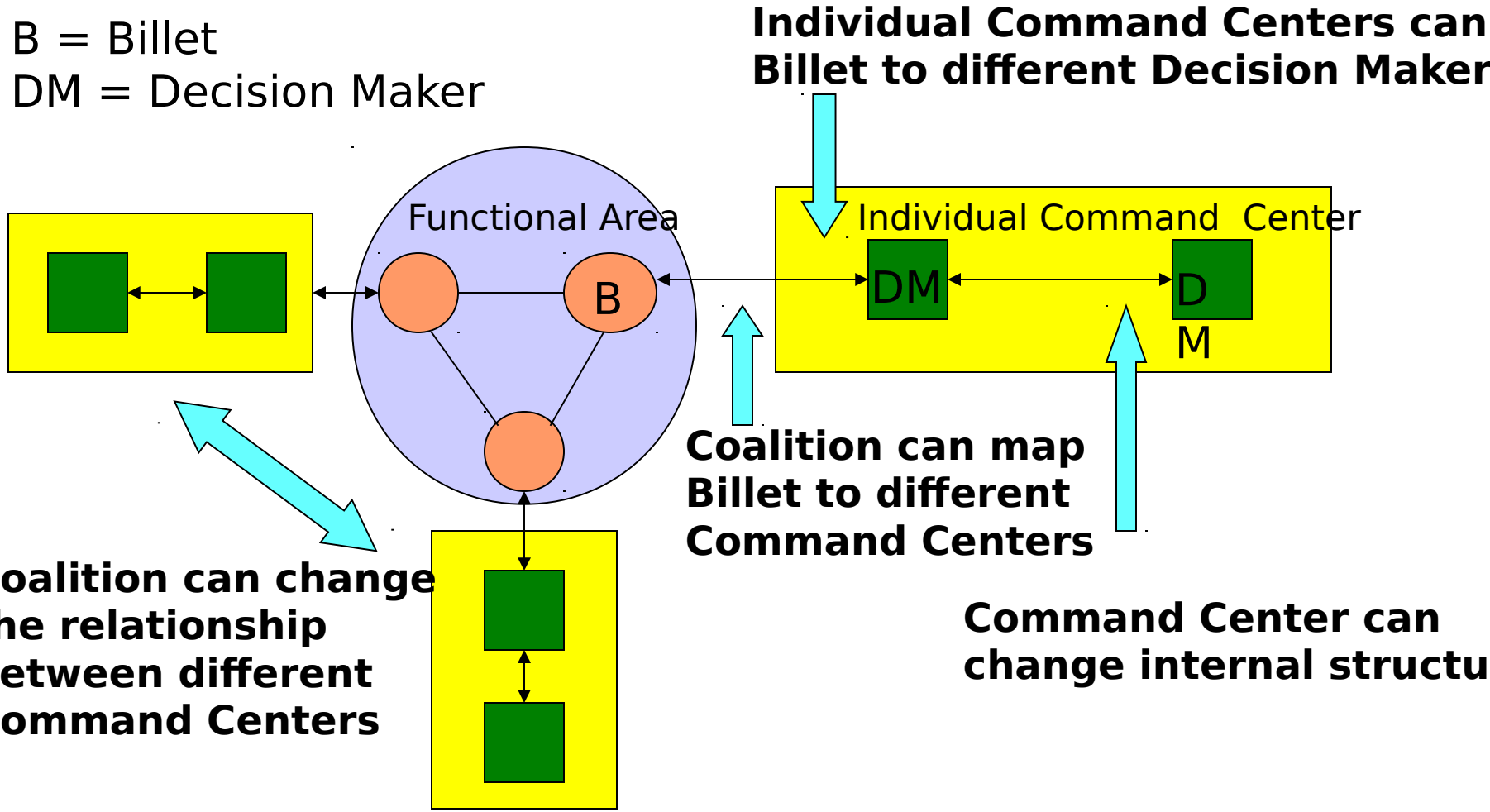
Introduction

- Coalitions are composed of cooperating command centers which may have systems of different capabilities.
- Different task assignment strategies can be used to assign coalition tasks to the participating command centers' systems.
- The different strategies result in different coalition architectures
  - may induce different levels of collaboration among the cooperating command centers,
  - may result in different levels of coalition performance.

Adaptive Heterogeneous Command Centers

- The composition of a coalition may change over time
  - New organizations may join after the initial coalition has been formed and some organizations may leave before the coalition's mission is accomplished.
- A model of a coalition with a dynamic architecture
  - Interactions affected by parameters of heterogeneity,
  - Structure affected by different task assignment strategies.

Adaptive Heterogeneous Command Centers



Coalition Architectures

- Functional – tasks assigned by functional capability; the same system will perform single task type throughout the Joint Area of Operations.
  - Efficient – redundancy is minimized
  - Narrow focus leads to expertise
  - High level of centralization (weak concept of overall mission)
- Divisional – tasks are assigned by geographic sector; the same system will do all task types in an assigned Area of Responsibility.
  - Flexible – broader capabilities
  - Regional focus leads to quick reaction time
  - Low levels of centralization (autonomous units)

Functional Architecture

- Task Assignment Strategy = System Self Assessment
  - Tasks are assigned based on each system in the coalition's assessment of its functional capabilities.
  - Leads to an integrated coalition structure with cooperation between different systems on an operation level.
  - Each command center present in each sector – dispersed effort.
- Emphasizes interdependent actions and requires a high level of communication (collaboration).
- A system must have the resources to handle multiple occurrences of the task through out the Joint Area of Operations.

Divisional Architecture

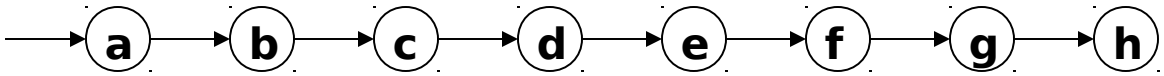
- Task Assignment Strategy = Geographic Sectors
  - A geographic sector is assigned to a system to be its Area of Responsibility.
  - Leads to a more autonomous coalition structure with minimum integration and cooperation between different systems only on a strategic level.
  - Maximum duplication of effort.
- Emphasizes independent actions; appropriate when the cooperating command centers prefer to operate independently.
- A system must have the diverse capabilities required to handle multiple types of tasks throughout its Area of Responsibility.

Hybrid Architecture

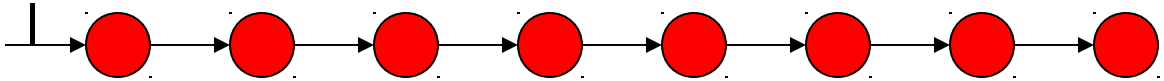
- As each coalition environment is unique, architectures designed for specific coalition missions may also be unique.
- A hybrid architecture can be created that uses aspects of both the functional and divisional architectures
  - Based on the use of geographic sectors,
  - Certain specialized tasks are assigned to a specific system to complete across all sectors.
- Appropriate when one participating command center is much larger than the others – or when one or more participating command center lacks certain capabilities.

Collaboration vs. Architecture

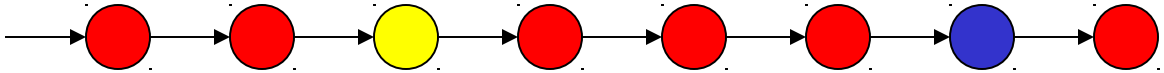
Task 7: Sector A



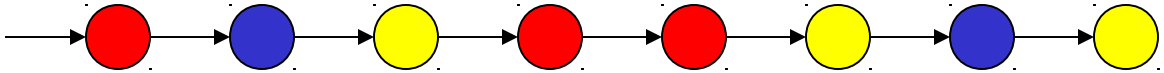
Divisional



Hybrid



Functional



Divisional	**Functional**
Controls all tasks in one sector	Controls all of one type of task
Generalized Knowledge	Specialized Knowledge
Multiple Resources	Single Resource
Independent	Interdependent
Local Communication	Global Communication

The Coalition Model

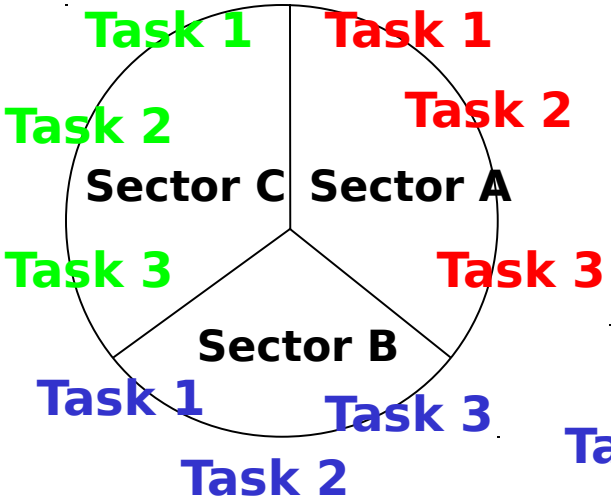
- A model of a coalition has been developed in order to test hypotheses about the behavior of different coalition architectures.
- Colored Petri nets were used to create an executable model which can be used to evaluate coalition performance.
- The model represents a template for the coalition design which can be populated with data from different coalition architectures in order to evaluate different aspects of coalition operations.
  - Three cooperating command centers (systems)
  - Three geographic sectors.
  - Five tasks with multiple subtasks occurring in each of the three sectors.

Task Assignment Strategies

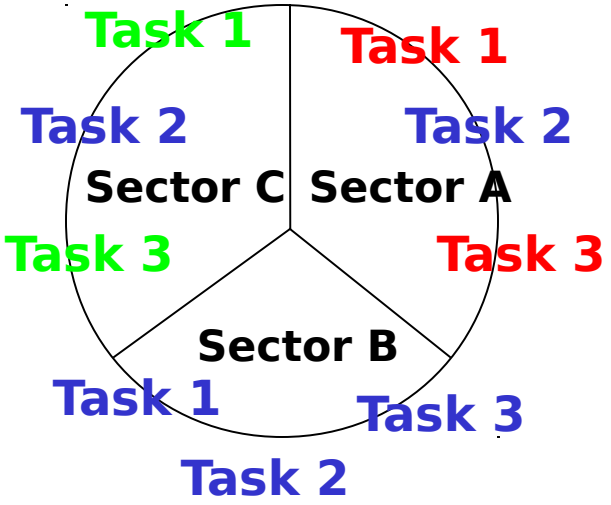
- Method 1: Tasks were assigned to the system responsible for the geographic area in which the task occurred.
  - Divisional Architecture
- Method 2: Tasks were assigned to the system that had functional capability on the type of task.
  - Functional Architecture
- Method 3: Tasks were first assigned based on geographic area and secondly on functional capability.
  - Hybrid Architecture

Task Assignment Strategies

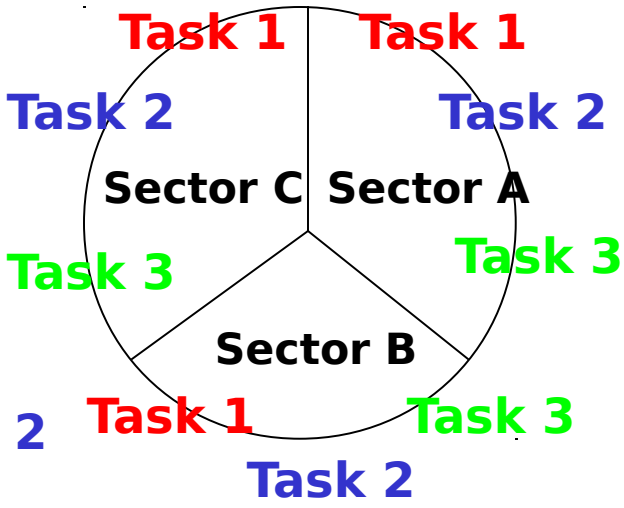
Divisional



Hybrid



Functional



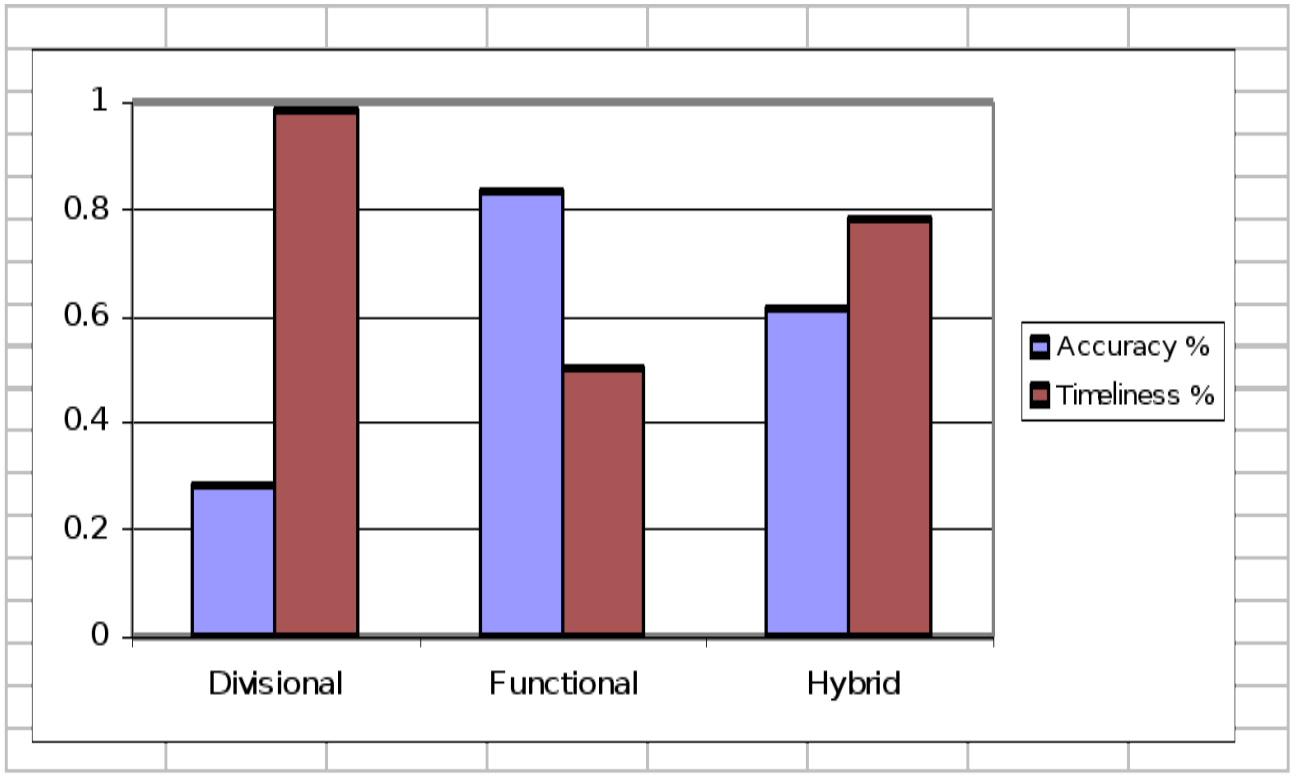
Coalition Performance

- Timeliness expresses the coalition's ability to respond to an incoming task within an allotted time.
  - The allotted time is the time interval over which the output produced by the coalition is effective in its environment.
- Accuracy expresses a coalition's ability to make a correct response to an incoming task.
  - The accuracy is described as an interval that contains the correct response plus or minus a margin of error within which the response is still acceptable.

Coalition Performance

- When a system performs an action on a task outside its current geographic location, the task incurs a delay.
  - Task assignments based on sectors are predicted to be timely but less accurate.
- When a system performs an action on a task without the required capability, the accuracy of the task decreases.
  - Task assignments based on system self-assessment are predicted to be accurate but less timely.

Simulation Results



Conclusions

- Task assignment strategy induces different levels in collaboration and effects coalition performance.
- Traditional schemes may not always be optimal in coalition operations.
  - Adjustments to functional assignment based on capabilities.
  - Adjustments to sector size based on troop strength.
- Investigating operational architectures resulting from task assignment strategy contributes to the larger question of designing heterogeneous command centers that can dynamically adapt over time.

Current Research

- Developing a research concept which will expand the coalition model to allow organizations to join and leave the coalition over time
  - Constraints include attributes of heterogeneity between different types of organizations
  - Dynamic structure for establishing (and disestablishing) links between the appropriate nodes of the cooperating command centers
- Scenario and Coalition Data to populate the model will be based on actual coalition experiences in Bosnia
  - Include Model Validation